



Reply to Price et al.: An inconvenient truth about the long-term forest change in western Canada: Competition is the primary driving force

Price et al. (1) object to our findings (2) that forest dynamics in western Canada is primarily driven by competition, not climate, but they provide no direct evidence to support their case. Price et al.'s (1) letter, in our opinion, misrepresents our study (2).

First, we cannot agree with the title that Price et al. (1) have suggested. Ecologists disagree about many things but few disagree that competition is a fundamental mechanism underlying the change of long-lived forest ecosystems, as predicted by decades of well-corroborated succession theory. Forests change over time and there is much evidence that such changes can be driven largely by competition. Perhaps failure to understand the central role of competition in succession lead Price et al. to assert that climate is the only driver of forest dynamics, but they provide no evidence to support such an assertion.

Second, Price et al. (1) insist that the climatic moisture index (CMI) should be retained as a key predictor in modeling change in trembling aspen and perhaps other species. Although CMI was significant in the absence of other climatic variables, when other equally meaningful climatic variables—such as precipitation, temperature, and seasonality—were included in model selection, CMI was simply not retained. As might be expected, given the complexity of nature, we observed no uniform signal of climate or competition across species. Instead, as clearly stated in our paper (2), the signals of climate and competition varied widely across provinces, elevation, eozones, tree size, forest age, and species. Nonetheless, the overall evidence consistently

and overwhelmingly points to the importance of competition in driving the change in the three basic tree demographic rates. Parsimony is a fundamental principle of scientific inference, particularly from models of complex interactions in high dimensional space as spanned by ecological and climatic sciences (3). We see no need to force a particular variable into the models to support a preconceived notion at the cost of violating a basic scientific principle.

Third, Price et al. (1) raise concern about possible sampling bias in permanent sample plot data. Our unprecedented data are repeated measurements, spanning more than half a century, covering much of western Canada, and include all major tree species. Permanent sample plots were not originally selected in relation to any particular hypothesis. As shown in figure S1 of our paper (2), our data did not overemphasize the 1970–1990 period that Price et al. (1) claim was characterized by major drought, but was evenly distributed across the entire study period (1958–2009). Furthermore, we excluded sites that suffered major disturbances to avoid confounding such effects with background (noncatastrophic) demographic rates (4, 5). We agree that climate change can alter the frequency and intensity of disturbance regimes, such as forest fires and pest outbreaks, to name two, thus accelerating the change of forests; however, disturbance was not the focus of our study (2).

In conclusion, our findings that climate has not been as important in the recent past in western Canada as has competition to

forest dynamics is supported by the data and analysis of our report (2). We suggest that more progress can be achieved by careful analysis and reanalysis of freely available empirical data than by objecting to results such as ours, which do not meet preconceived notions. As pointed out elsewhere in the ongoing debate about climate, truth may not always be convenient.

Fangliang He^{a,1}, Shongming Huang^b, and Jian Zhang^a

^aDepartment of Renewable Resources, University of Alberta, Edmonton, AB, Canada T6G 2H1; and ^bForest Management Branch, Alberta Ministry of Agriculture and Forestry, Edmonton, AB, Canada T5K 2M4

1 Price DT, Cooke BJ, Metsaranta JM, Kurz WA (2015) If forest dynamics in Canada's west are driven mainly by competition, why did they change? Half-century evidence says: Climate change. *Proc Natl Acad Sci USA*, 10.1073/pnas.1508245112.

2 Zhang J, Huang S, He F (2015) Half-century evidence from western Canada shows forest dynamics are primarily driven by competition followed by climate. *Proc Natl Acad Sci USA* 112(13):4009–4014.

3 Johnson JB, Omland KS (2004) Model selection in ecology and evolution. *Trends Ecol Evol* 19(2):101–108.

4 van Mantgem PJ, et al. (2009) Widespread increase of tree mortality rates in the western United States. *Science* 323(5913):521–524.

5 Peng C, et al. (2011) A drought-induced pervasive increase in tree mortality across Canada's boreal forests. *Nat Clim Chang* 1(9):467–471.

Author contributions: F.H., S.H., and J.Z. designed research; F.H., S.H., and J.Z. performed research; and F.H., S.H., and J.Z. wrote the paper.

The authors declare no conflict of interest.

¹To whom correspondence should be addressed. Email: fhe@ualberta.ca.